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MICROSCOPICAL MINERALOGY.

Petrographical Tables: an Aid to the Microscopical Determination of Rock-forming Minerals. By Prof. H. Rosenbusch. Translated and Edited (with the Author's permission) by Dr. F. H. Hatch, of H.M. Geological Survey. (London: Swan Sonnenschein and Co., 1889.)

DR. HATCH has rendered a great service to English-speaking students by the preparation of this careful translation of Prof. Rosenbusch's very admirable "Hülfstabellen zur mikroskopischen Mineralbestimmung in Gesteinen," which appeared a few months ago. These tables may indeed be regarded as an index or summary to the same author's invaluable "Mikroskopische Physiographie der petrographisch wichtigen Mineralien," the English translation of the second edition of which, by Mr. J. P. Iddings, was reviewed not long ago in the pages of NATURE. The two works together supply a want that has long been felt by English students—namely, a complete summary of all that has been done in the way of making the optical and other characters of minerals available as means of recognizing them when seen in thin sections of rocks under the microscope.

Of the admirably lucid and exhaustive manner in which Prof. Rosenbusch, in these works, has compared, arranged, and not unfrequently verified the results accumulated by Zirkel, Tschermak, Von Lasaulx, Fouqué, Michel Lévy, and a host of other observers, who, during the last thirty years, have followed up the suggestive work of Mr. Sorby, the original founder of the science of microscopic petrology, it is not necessary to speak in this place. Geologists and mineralogists are alike placed under a great debt of gratitude to one who—besides making many original observations of great value himself—has so admirably systematized and correlated the results obtained by a great number of other independent workers; nor can they forget that Prof. Rosenbusch is the founder of the now famous Petrographical School of Heidelberg, in which many of the foremost investigators of this branch of science, now engaged in the study of rocks on both sides of the Atlantic, have been so well trained.

The first attempt at the construction of a series of tables, on something like the same lines as those in the work before us, was made as long ago as the year 1876, by Dr. C. Doelter, of Vienna, a pupil of Prof. Tschermak. It was only three years before this that the earliest endeavours to systematize the results arrived at by the study of rocks, with the aid of transparent sections under the microscope, had been given to the world in Zirkel's "Die mikroskopische Beschaffenheit der Mineralien und Gesteine," and in Rosenbusch's "Mikroskopische Physiographie der petrographisch wichtigen Mineralien": the former dealing more particularly with various characteristic peculiarities of the different rock-forming minerals, as a means by which they may be identified in thin sections; the latter aiming at the utilization of the important results arrived at by Des Cloizeaux and his pupils, in their important determinations of the "optical constants" of minerals, as a basis for the exact diagnosis of the constitution of rocks, under the difficult conditions presented by very thin sections which intersect the crystals in varying and unknown directions. Doelter's tables, appearing after these systematic works, constituted a very valuable addition to the scanty petrographical literature of that day. In this work of Doelter, "Die Bestimmung der petrographisch wichtigeren Mineralien durch das Mikroskop; eine Anleitung zur mikroskopischen Gesteins-Analyse," an attempt is made to construct a mineralogical key, similar to the "keys" published with certain floras, and so familiar to all students of systematic botany. Every mineral observed under the microscope was to be submitted to certain optical tests, and then relegated to a particular class; and by the further applications of the similar tests new points of distinction were to be detected, till at last the species or variety had been correctly identified. The process recommended to be pursued was, in fact, exactly similar to that which is usually followed by chemical students in the work of qualitative analysis.

In 1885, Dr. Eugen Hussak, of Gratz, a pupil of Dr. Doelter, published his "Anleitung zum Bestimmen der Gesteinbildenden Mineralien," in which the same method of procedure is illustrated in greater detail, and with the assistance of many new facts and methods that had been discovered since the publication of Dr. Doelter's tables.

In 1888, MM. A. Michel Lévy and A. Lacroix issued their very valuable work "Les Minéraux des Roches," in which the characters of the rock-forming minerals are also exhibited in a series of tables. In this treatise, the authors—we think wisely—abandoned the idea of making anything like analytical keys for the determination of the rock-forming minerals, and arranged the various species and varieties simply in alphabetical order. Just as few practical botanists or chemists find it necessary to go through the whole of the elaborate schemes of research contained in the text-books, though these may be of much educational value to a beginner, so no student of the microscopic character of rocks is called upon to pursue the exhaustive method of analysis illustrated in the tables of Doelter and Hussak. As a rule, the result of a preliminary examination of a mineral seen in a thin section is to make it obvious that we are dealing with some one out of two or three possible forms; and what the observer most needs for deciding between these, is a statement of the characteristic and distinctive peculiarities of every species, arranged in such a manner as to facilitate reference to them.

Prof. Rosenbusch, in his tables, combines to some extent the methods of his predecessors. The main grouping of the rock-forming minerals is into (1) singly-refracting minerals; (2) doubly-refracting uniaxial minerals (there is an unfortunate misprint in Dr. Hatch's translation of "biaxial" for "uniaxial" in table ii.*b*); and (3) doubly-refracting biaxial minerals. In each of these classes, the several species or varieties are arranged in groups according to their general affinities, and irrespectively of their system of crystallization. Dr. Hatch has very wisely supplemented this arrangement by an alphabetical index, and has thus secured almost the same facility of reference which is so conspicuous and valuable a feature in the tables of Michel Lévy and Lacroix.

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If we compare the several series of tables to which we have referred, it is impossible to help being struck by the numerous and important additions which have been made to our knowledge of this branch of science during the last decade. Doelter, in 1876, recognized only 64 species or well-marked varieties of minerals as occurring as rock-constituents; Hussak, in 1885, raised this number to 107; Michel Lévy and Lacroix, in 1888, give 160; and Rosenbusch, in 1889, no less than 162 rock-forming types, although none of the opaque minerals are included in these later works.

Still more striking is the contrast between the earlier and later works of this class, when we come to examine the methods employed for the discrimination of the several species of minerals. In the two later works, the results obtained by the important methods of mineral isolation, first discovered and pursued in the famous petrographical laboratory of the Collège de France, under MM. Fouqué and Michel Lévy, and the methods of micro-chemical analysis so well elaborated by Bořický, Behrens, Streng, and other observers are all made use of. Perhaps the most important and characteristic new feature in the two latest published works will be found in the attempt to substitute exact measurements of the double refraction of minerals, for vague statements as to the intensity of the colours which they give with polarized light. It is perhaps too early to pronounce upon the applicability and practical value of the ingenious contrivances of M. E. Bertrand, and of M. Michel Lévy for determining respectively the index of refraction and the double refraction in the thin microscopic sections with which petrographers have to deal. If, however, the micro-refractometer and the *comparateur* fulfil their promise, it is not too much to hope that the methods of discriminating minerals in cleavage-flakes and thin sections will be as greatly facilitated by the exact determination of their refraction and double refraction as by the study of their positions of extinction or of the optical pictures which they give with convergent polarized light.

We have spoken of these tables as being of very great service as an index or summary of the excellent "Physiographie" of Prof. Rosenbusch, and, indeed, we think their chief value will be realized when they are thus employed in conjunction with that important systematic work. In the treatise itself, it has been possible to point out many important limitations and qualifications of general statements, though these have of course to be frequently omitted in the terse indications necessary for the tabular mode of presentation.

An illustration of the caution which ought to be exercised in applying determinations of the so-called optical "constants" of species as *absolute standards* for the identification of unknown forms is afforded to us in the work before us. In many basalts, like those of Bohemia, there occur large porphyritic crystals of an undoubted amphibole. It has long been known that this "basaltic hornblende" presents some very anomalous characters, especially in respect to its pleochroism and absorption, as well as to the curious chemical changes which it is found in whole or in part to have undergone. The important series of determinations of Michel Lévy and Lacroix, which have been incorporated in these tables by Rosenbusch, show that this form of amphibole is not less anomalous in its double refraction, than in some of its other properties. While the difference between the maximum and minimum indices of refraction in all other forms of hornblende ranges between 0·021 and 0·028, that of the basaltic hornblende is found to be as high as 0·072! Whether this remarkable and anomalous departure from the typical characters of an amphibole can be accounted for by the peculiar and somewhat exceptional conditions under which this particular variety is found to occur, it is not necessary here to discuss. But petrographical students cannot be too frequently reminded that—as the isolation and chemical analyses of rock constituents have so often proved—the minerals in rocks may present important differences from those which crystallize out in veins and cavities, and constitute the "types" of our mineralogical collections. Moreover, even small differences in the proportion of certain chemical ingredients have been shown again and again to exercise a very important influence in modifying the values of the so-called optical "constants."

The great interest of the determinations of Michel Lévy and Lacroix, which are adopted in these tables—and indeed constitute their most novel and striking feature—is derived from the fact that the observations on which they are based were made upon actual rock-constituents, and not upon the large crystals, often of exceptional character, which have hitherto been chiefly employed in investigations of this kind. A reference to the numbers representing the refraction and double-refraction of ægyrine among the pyroxenes, and of the several varieties of the epidotes and scapolites, will show that this remarkable case of basaltic hornblende does not by any means stand alone. We trust that the valuable contributions to our knowledge of the characteristics of the actual rock-forming species and varieties of minerals which have been made in M. Fouqué's laboratory, will be greatly added to in the future:—for by such researches only can we hope that many of the difficulties and anomalies which still surround the pursuit of petrological science will in the end be removed.

With the kind co-operation of Prof. Rosenbusch, Dr. Hatch has been enabled to bring these tables quite up to date; and he has fairly earned the thanks of all students of petrography by the careful and thorough manner in which he has performed his task. JOHN W. JUDD.

THE INFLUENCE OF SNOW ON THE SOIL AND ATMOSPHERE.

Der Einfluss einer Schneedecke auf Boden, Klima und Wetter. Von A. Woeikof. Pp. 1–115. *Geographische Abhandlungen*, herausgegeben von Prof. Dr. Albrecht Penck in Wien, Band III. Heft 3, pp. 321–435. (Wien und Olmütz: Eduard Hölzel, 1889.)

IN a country such as ours, which lies on the borders of a great ocean and a great continent, the protean phases of the weather are so greatly determined for us by causes which operate at a distance from our shores, that the influence of any temporary variation in the condition of the local surface is comparatively unimportant, and, except locally, perhaps altogether inappreciable. But the further we recede from this border-land and penetrate to the interior of the continent, the more influential do such temporary

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